

Hadron Collider Phenomenology (Tevatron, LHC, RHIC) with emphasis on quantitative QCD predictions of signals and standard model backgrounds – Recent Examples:

## 1. Trileptons and the Search for Supersymmetry

with Zack Sullivan, Phys Rev. D78:034030, 2008 and e-Print: arXiv:0909.2131

- $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$  ( “Golden” SUSY channel) vs. leptons from SM Sources. **Emphasis on the importance of isolated leptons from heavy flavor decays,  $b \rightarrow lX$**

## 2. NLO Cross Sections for New Heavy Quark and Lepton Production at three LHC Energies

with Qing-Hong Cao, ANL-HEP-PR-09-93, e-Print: arXiv:0909.3555

## 3. Longitudinal Parity-Violating Asymmetry in Hadronic Decays of $W$ 's in Polarized Proton Collisions at RHIC

with Pavel Nadolsky, Phys.Rev. D78:114010, 2008

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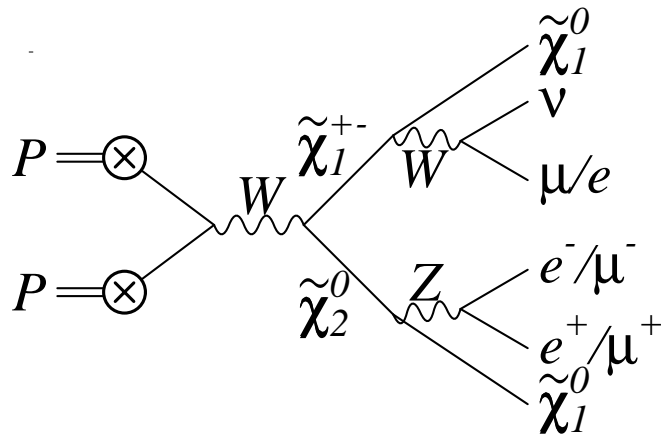
## 4. Phenomenology of Double Parton Scattering at LHC

with Chris Jackson and Gabe Shaughnessy, draft in preparation

## 5. Model Independent Constraints Among the $Wtb$ , $Zb\bar{b}$ , and $Zt\bar{t}$ Couplings

with Qing-Hong Cao and Ian Low, e-Print: arXiv:0907.2191; Phys Rev D

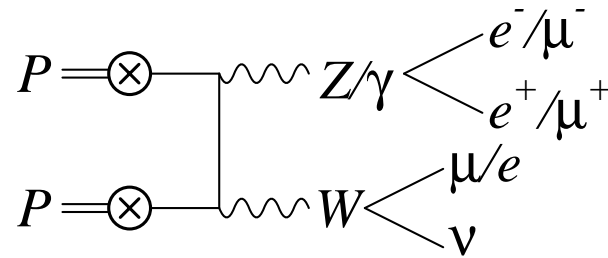
# Trileptons at LHC



$\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \rightarrow l^+ l^- l^\pm + \cancel{E}_T$  is a golden signature of supersymmetry.

CMS and ATLAS have analyses designed to observe this signal.

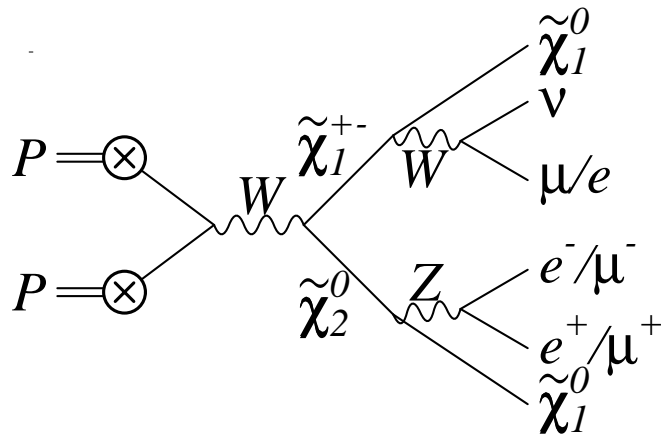
CMS TDR V.2&Note 2006/113; ATLAS CSC 7



$WZ$  is thought to be the largest source of low- $p_T$  trileptons at LHC.

$W\gamma^*$  is not always included but should be.

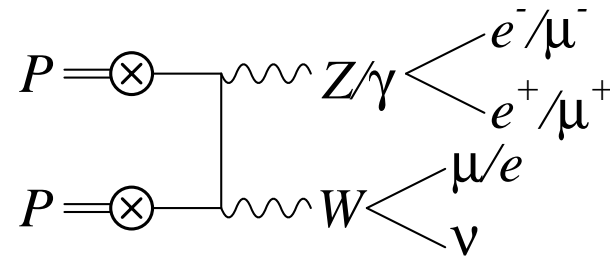
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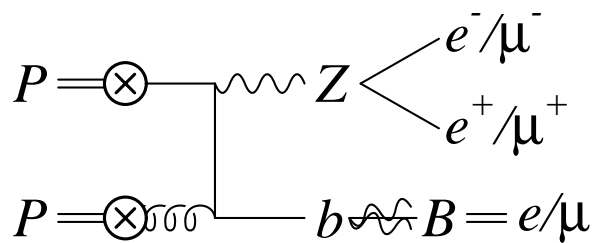
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Many processes with heavy flavors:

$bZ/\gamma, b\bar{b}Z/\gamma, cZ/\gamma, c\bar{c}Z/\gamma, b\bar{b}W, c\bar{c}W, t\bar{t}, tW, t\bar{b}$

How important are leptons from heavy flavor ( $b, c$ ) decays?

NOTE: All photons are virtual, and split to  $l^+ l^-$

# Event simulations

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We reproduced the analysis chains described in

1. CMS: CMS TDR V.2&Note 2006/113
2. ATLAS: ATLAS CSC 7

but we included, in addition, the contributions from processes with heavy flavors:  $bZ/\gamma$ ,  $b\bar{b}Z/\gamma$ ,  $cZ/\gamma$ ,  $c\bar{c}Z/\gamma$ ,  $b\bar{b}W$ ,  $c\bar{c}W$ ,  $t\bar{t}$ ,  $tW$ ,  $t\bar{b}$

## Simulation method

- Matrix elements computed in MadEvent (spin correlations included)
- MadEvent results fed through PYTHIA showering.

PYTHIA output is fed through a modified PGS detector simulation that reproduces CMS and ATLAS full detector results to 10%.

## Important Analysis Cuts

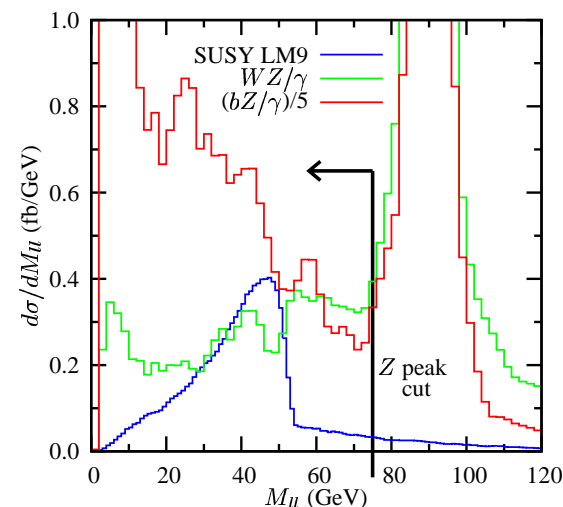
- Require 3 isolated leptons
- Require no jets with  $E_T > 30$  GeV
- Require  $M_{ll}^{\text{OSSF}} < 75$  GeV

# Trileptons: SUSY & SM at CMS w/ 30 fb<sup>-1</sup>

Analysis cuts:

- 3 leptons
- No jets ( $E_{Tj} > 30$  GeV)
- Remove Z peak  
(demand  $M_{ll}^{\text{OSSF}} < 75$  GeV)

	$N^l = 3,$	$M_{ll}^{\text{OSSF}}$
Channel	NoJets	$< 75$ GeV
LM9	248	243
LM7	126	123
LM1	46	44
$WZ/\gamma$	1880	538
$t\bar{t}$	1540	814
$tW$	273	146
$t\bar{b}$	1.1	1.0
$bZ/\gamma$	14000	6870
$cZ/\gamma$	3450	1400
$b\bar{b}Z/\gamma$	8990	2220
$c\bar{c}Z/\gamma$	4680	1830
$b\bar{b}W$	9.1	7.6
$c\bar{c}W$	0.19	0.15

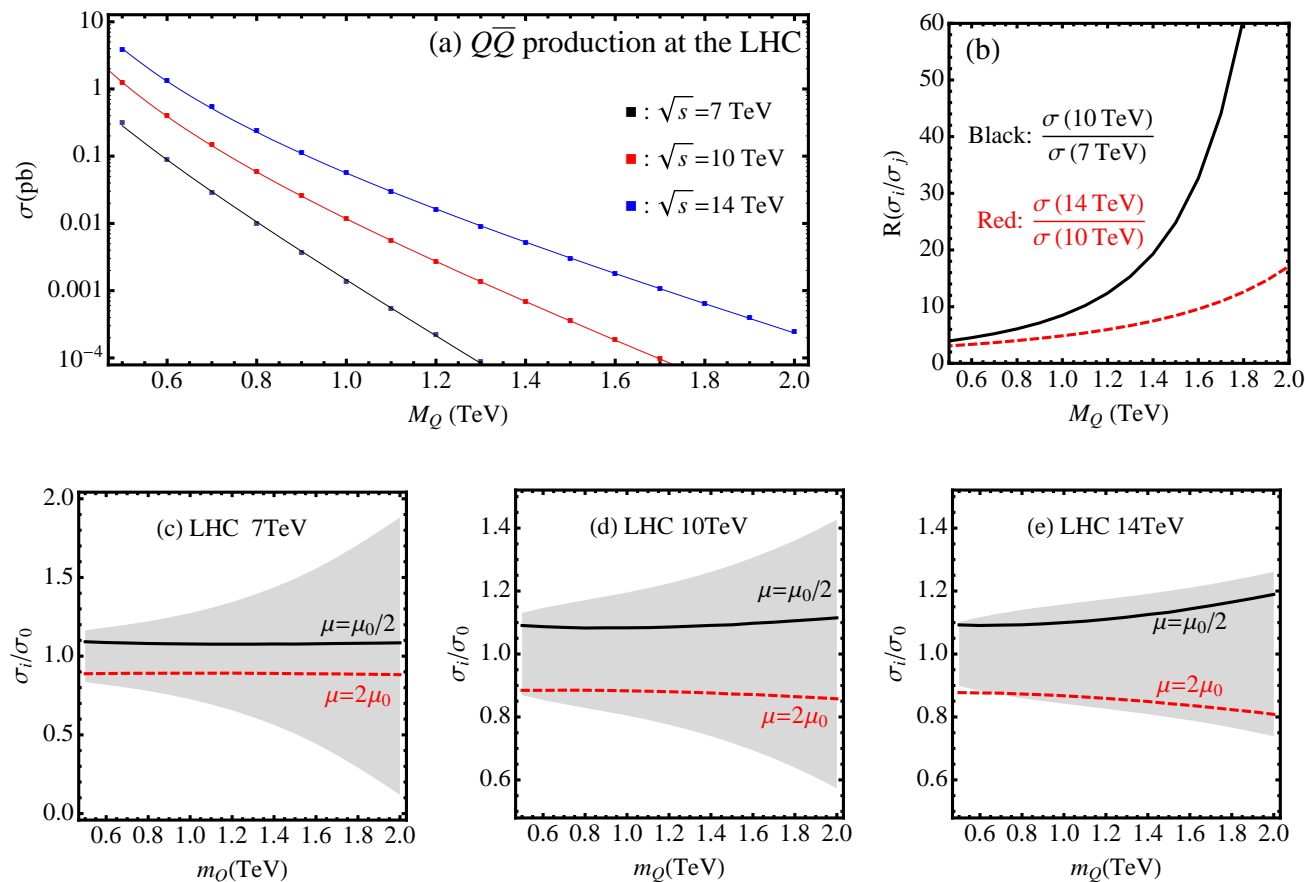


Z+heavy flavor decays are  
**10×**  $WZ/\gamma + t\bar{t}$ !

We propose new cuts:  
 $\cancel{E}_T > 30$  GeV; opening angles

# NLO $Q\bar{Q}$ , Single $Q$ , and Exotic Lepton Cross Sections at LHC

- Heavy quarks and leptons expected in various models of New Physics
- NLO  $Q\bar{Q}$  cross sections vs  $m_Q$  at 3 LHC energies plus full exploration of PDF uncertainties (shaded bands)



- NLO predictions also for production of a single heavy (T) quark, and for exotic heavy leptons

## *Other professional activities*

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### – Current Principal Examples:

1. **Collider Physics 2009: Joint ANL and IIT Theory Workshop**  
May 18 - 22 , 2009, with **Zack Sullivan, Chris Jackson**, Ian Low, Tim Tait, Carlos Wagner  
funds from IIT and ANL; see <http://www.hep.anl.gov/jackson/CP09/Program.html>
2. **Organizer, CTEQ Summer School, 2009**
3. **Lead organizer, Aspen Center for Physics Four-week Workshop, Summer 2010**  
**“FOREFRONT QCD and LHC DISCOVERIES”**  
with Frank Petriello, Dave Soper, Bryan Webber, Giulia Zanderighi
4. **Search Committee, Senior Computational Scientists, ANL Lab Wide**  
A dozen or more such positions to be filled, coupled with ANL Initiatives in Computer Science; new Theory and Computer Science Center
5. **ANL Lab-Wide Postdoctoral Committee**  
Recommendations to Lab Director of Named and Director’s Postdoc Fellows
6. **Moriond Scientific Program Committee, .....**